

AMENDMENT UNDER 37 C.F.R. § 1.111  
U.S. Application No.: 09/876,955

**REMARKS**

Claims 1-34 are all the claims pending in the application.

**I. Claim Rejection - Double Patenting**

Claims 1-34 stand rejected under the judicially created doctrine of obviousness-type double patenting. Applicants submit herewith a terminal disclaimer over Kenan 6,268,093, thereby making this rejection moot.

**II. Claim Rejection - Obviousness (Ferguson in view of Kuwabara)**

Claims 1, 2, 5, 6, 9, 11-16, 19, 21 and 22 stand rejected as being unpatentable over Ferguson, USP 6,327,033, in view of Kuwabara USP 6,580,502. Applicants respectfully traverse this rejection for the following reasons.

All of the pending claims relate to, and explicitly recite, an aerial imaging inspection method and apparatus. As can be clearly understood by an artisan in the art, no such system or method are disclosed or even remotely suggested by the cited references, or any combinations thereof. Rather, the cited references disclose the traditional bright-field inspection of masks (Ferguson) and wafers (Kuwabara). Bright-field inspection systems are very different in their concept and implementation than an aerial imaging system. To help in understanding the differences, Applicants provide in Appendix A, attached hereto, an article published in OE Magazine of the SPIE organization - a foremost authority in defect inspection in the

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semiconductor and other industries - explaining the difference between traditional mask inspection and aerial imaging mask inspection. Additionally, Applicants further provide the following explanation.

A bright field image is an image experience when one takes a conventional picture using a camera. In fact, using a digital camera having a CCD sensor is very much like the bright field imaging described in Ferguson, except that in Ferguson the illumination is done from behind the object pictured. Still, it is a traditional bright field image of the object. That is, it is an image of the object itself, in Ferguson's case, an image of the reticle itself. As explained in the cited references, these bright-field images of the reticle themselves are used to examine for defects in the reticles. See, e.g., Ferguson, col. 4, lns 51-64 ("...collecting images of the photomask ... calculating differential image of the mask..."). Consequently, using such systems one can detect defects as they appear on the image of the mask itself.

Aerial imaging, on the other hand, is a very different concept. In aerial imaging, the system does not produce an image of the reticle and does not search abnormalities on the article itself. Rather, in aerial imaging the image that is generated is the image that would be produced if the reticle was to be used in an exposure system (such as a stepper) and the abnormalities that are searched are abnormalities that will appear in such an image, not abnormalities on the reticle itself. That is, while the bright-field system of the prior art study the physical structure of the reticle itself, the claimed aerial imaging studies the image that would be produced from the reticle, not the reticle itself. This difference is explained in the subject specification and is also

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described in the OE article of Appendix A, in the paragraph under the heading Aerial Imaging vs. Mask Imaging.

To implement this concept, the claimed method and optical system are constructed so as to emulate the exposure conditions of an exposure system. Then, rather than projecting the generated image onto a wafer (as would be done in an exposure system) the image is optically picked up (from the air - thus aerial imaging) and is projected onto the CCD sensor. In this manner, the image that is generated is not an image of the reticle, but rather an image that would have been projected onto a wafer under an exposure conditions of an exposure tool. Then, the system analyzes the aerial images for defect, i.e., not the image of the reticle, but the projected aerial image.

For example, claim 1 recites:

“said plurality of aerial images being acquired in an aerial imaging inspection system and within a process window of said exposure system by emulating said set of exposure conditions” (emphasis added)

Nowhere in the cited references is there a disclosure or a suggestion to acquire aerial images by emulating a set of exposure conditions. Furthermore, claim 1 continues to recite:

“comparing said first and said second aerial images to each other to detect phase defects and errors in said phase shift mask”

Nowhere in the cited references is there a disclosure or a suggestion to compare aerial images in order to detect defects and errors in the mask. That is, in Ferguson it is disclosed that in order to find defects and errors in the phase shift mask one should compare two images of the mask itself.

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That seems reasonable as the objective of the investigation is to detect defects on the mask, so it stands to reason that one out to look at the mask. On the other hand, using the claimed invention one is actually finding defects on the mask that would cause errors on the wafer itself, since what is investigated is not the image of the mask, but rather an aerial image created by the mask.

As can be readily understood by artisans in the art, Kuwabara fails to remedy any of the deficiencies of Ferguson, as Kuwabara discloses a wafer inspection system, not a mask inspection system. As is well known, wafers are not transparent, so an image cannot be obtained using transmitted light. Consequently, one cannot, and have no reason to, attempt to create an aerial image using transmitted light through the wafer.

All of the pending independent claims explicitly recite the “aerial imaging” feature and are, therefore, patentable over the cited art. Other features are recited in the dependent claims that further differentiate from the cited art. For example, claim 6 recites that the result is used to generate a map for the entire mask. Therefore, differential image 780 of Ferguson cannot be read on this limitation. Claim 22 recites “a numerical aperture diaphragm for reproducing said set of exposure conditions.” While Ferguson discloses a numerical aperture, it does not teach or suggest to use a numerical aperture diaphragm for reproducing the exposure condition of an exposure tool. That is, in the claimed invention, the inspection tool includes a numerical aperture diaphragm so that the inspection tool can be adjusted to emulate the exposure condition of an exposure tool.

At least for these reasons, Applicants respectfully submit that none of the cited art, or any combination thereof, make any of the rejected claims unpatentable.

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III. Claim Rejection - Obviousness (Ferguson in view of Kuwabara and Shiraishi)

Claims 3, 4, 7, 8, 10, 17, 18, 20, and 23 - 33 stand rejected as being unpatentable over Ferguson, USP 6,327,033, in view of Kuwabara USP 6,580,502 and further in view of Shiraishi, USP 5,576,829. Applicants respectfully traverse this rejection for the following reasons.

As noted above, all of the pending claims relate to aerial imaging, and none of the cited art or any combination thereof discloses or suggests the use of aerial imaging as claimed herein. More specifically, with respect to claim 23, it has been already pointed above that Fergusons disclosure of a numerical aperture does not teach or suggest the use of the “numerical aperture diaphragm for reproducing said set of exposure conditions” as claimed. That is, in the claimed invention, the numerical aperture diaphragm is used in an inspection tool to reproduce the set of exposure conditions of an exposure tool. Ferguson never discloses or suggests that the inspection system should be set to reproduce the exposure condition of an exposure tool. To the contrary, Ferguson discloses a fixed numerical aperture (e.g., 0.625, col. 2, ln. 54). Nowhere is Ferguson teaches or suggests to have the inspection tool’s numerical aperture adjusted to simulate an exposure tool’s exposure conditions.

With respect to claims 25 and 26, while it is alleged that Shiraishi discloses changing the direction of illumination, this is not what is claimed. Rather, the claims recite using a pulsating light source or using a pulsating laser. Shiraishi fails to disclose such a light source.

At least for these reasons, Applicants respectfully submit that none of the cited art, or any combination thereof, make any of the rejected claims unpatentable.

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IV. Claim Rejection - Obviousness (Ferguson in view of Kuwabara, Shiraishi and Oohashi)

Claim 34 stand rejected as being unpatentable over Ferguson, USP 6,327,033, in view of Kuwabara USP 6,580,502 and Shiraishi, USP 5,576,829 and further in view of Oohashi, USP 6,078,393. Applicants respectfully traverse this rejection for the following reasons.

Claim 34 depends from claim 23, which explicitly recite aerial imaging. As discussed above, claim 23 is patentable over the cited art, as none of the cited art or any combination thereof discloses or suggests the limitations of claim 23. Therefore, claim 34 is allowable at least by its dependence from claim 23.

At least for these reasons, Applicants respectfully submit that none of the cited art, or any combination thereof, make claim 23 unpatentable.

V. Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

Atty. Docket No: 005329 USA Y1/MASK/RT/OR  
**PATENT APPLICATION**

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The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,


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MOUNTAIN VIEW OFFICE

**23493**

CUSTOMER NUMBER

Date: October 21, 2005

  
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Date: October 21, 2005

Signed:   
Mariann Tam

## **APPENDIX A**